Leibniz-Institut für
Ostseeforschung Warnemünde
an der Universität Rostock

Date: 09.02.09

Cruise Report

Compiled by: Dr. Joanna Waniek

F.S.Poseidon Cruise No.: 377

Dates of Cruise: from 08.12.2008 to 22.12.2008

Areas of Research: Physical Oceanography, Marine Biology, Genetics

Port Calls: Las Palmas

Institute: Institut für Ostseeforschung Warnemünde, Seestrasse 15, 18119 Rostock

Chief Scientist: Dr. Joanna Waniek

Number of Scientists: 9

Project: (DFG. WA2157/1-1, WA2157/2-1).

Cruise Report

This cruise report consists of 19 pages including cover:

1. Scientific crew

Name	Function	Institute	Leg
Dr. Waniek, Joanna	Chief scientist	IOW	377
Krüger, Siegfried	Scientist	IOW	377
Brust, Juliane	PhD Student	IOW	377
Howa, Helene	Scientist	BIAF	377
Robotim, Andrea	Student	DGM, INETI	377
Huth, Hartmut	Technician	IOW	377
Thiede, Carl	Scientist	TU Berlin	377
Kebkal, Oleksiy	Technician	EvoLogics	377
Pleskach, Georgiy	Technician	EvoLogics	377
Total: 9			

IOW	Institut für Ostseeforschung Warnemünde
BIAF	Actual & Fossil Bio-Indicator, University Angers, France
LNEG	Laboratorio Nacional de Engenharia e Geologia, Departamento de Geologia Marinha
TU Berlin	Technische Universität Berlin, Institut für Konstruktion, Mikro- und Medizintechnik, FB Mikrotechnik
Evologics	EvoLogics GmbH, FuE Bionik

Chief scientist:

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2. Research programme

The cruise P377 from Las Palmas to Las Palmas in December 2008 (08.12-22.12.2008) on board R/V Poseidon had two objectives:
The first objective was to investigate the water column properties along a meridional transect (22°W between 30°N to 36°N) in order to a) characterize the conditions prior to the bloom, b) localize the position of the Azores Front and c) to understand the changes in biogeochemical properties. The work along the meridional transect consisted of combined CTD (2000m) & Multi Closing Net (MCN, 100m, 700m and 2000m) stations. Samples for nutrient analysis, chlorophyll a, SPM and molecular genetics and dissolution experiments on planktic foraminifers were taken at selected depths based on the chlorophyll a-fluorescence profiles measured by means of the CTD. Additional measurements using CTD and MCN were carried out at the ESTOC station. The work is funded by the DFG through two projects (WA2157/1-1, WA2157/2-1). The second aim was to carry out tests of a new technology, the so-called DNS Systems (Druckneutrale System).

3. Narrative of the cruise with technical details

8th of December 2008: R/V Poseidon depart at 9:30am from Las Palmas towards the ESTOC station (29° 09.99' N 015° 20.00' W), which was set as the test station (CTD, MSN) of the cruise. Additionally we plan to take samples for our Spanish colleagues for nutrients, chlorophyll a, and a CTD cast down to the sea floor. At ESTOC R/V Poseidon arrives at 6 pm. Both the CTD and the MCN are working well. In good weather conditions are good (wind 3-4 Bft) R/V Poseidon sails towards out main working area along 22°W.
9th of December 2008: We are still on transit under relatively good weather (wind 6 Bft) conditions. However the swell is increasing (~3m).
10th of December 2008: In the evening (6pm) the hydrographic work on the meridional transect along 22°W starts with a CTD and MSN deployments at 30°N. Both instruments work without any problems.
11th of December 2008: Weather conditions: 5Bft, tendency increasing. The work along the 22ºW transect continuous towards the mooring position Kiel276 (33ºN, 22ºW) with CTD, MSN and XBT deployments.
12th of December 2008: After a 2000m CTD cast at 33°N the further station work is cancelled because of the weather conditions. Meanwhile the sea reaches 6-7Bft, tendency still increasing. We are sailing to 33°30N in the hope that the weather improves sufficiently and we are able to continue our hydrographic investigations. At stations 33°30N, 34°N and 34°30N XBT's are deployed, because CTD work is not possible due to bad weather.

13th of December 2008: In the morning R/V Poseidon arrives at 35°N, 22°W. Under slightly better weather conditions we are able to run the CTD and a series of MSN casts. Also some acoustical tests with the ROV head are carried out. During the night the weather gets even worth. R/V Poseidon sails with 3kn against the wind. At 35°19.58'N around 10pm a XBT is deployed just before the station work in this area is cancelled. Bad-weather conditions with wind force around 8Bft and high sea/swell make the station work impossible. The most northern stations along the 22ºW meridian are abandoned. R/V Poseidon heads south of Tenerife to hide near the land.

14th -17th December 2008: R/V Poseidon is on transit to the working area south of Tenerife. We are still waiting for the permission to work in the area, as this region was not notified.

17th of December 2008: We have the permission to start the acoustic and ROV-head tests. We resume our work in the morning on 17th of December. From now on to the end of the cruise we will be working only during the day.

17th-20th of December 2008: Trial work consisting of acoustic test, test with the ROV head and tests of some DNS components at the CTD-Rosette. The station work finishes at 2pm on 20th December.

21st of December 2008: R/V Poseidon arrives in the harbour of Las Palmas at 1pm.

4. Scientific report and first results

4.1 Hydrography incl. sampling (J. Waniek & J. Brust)

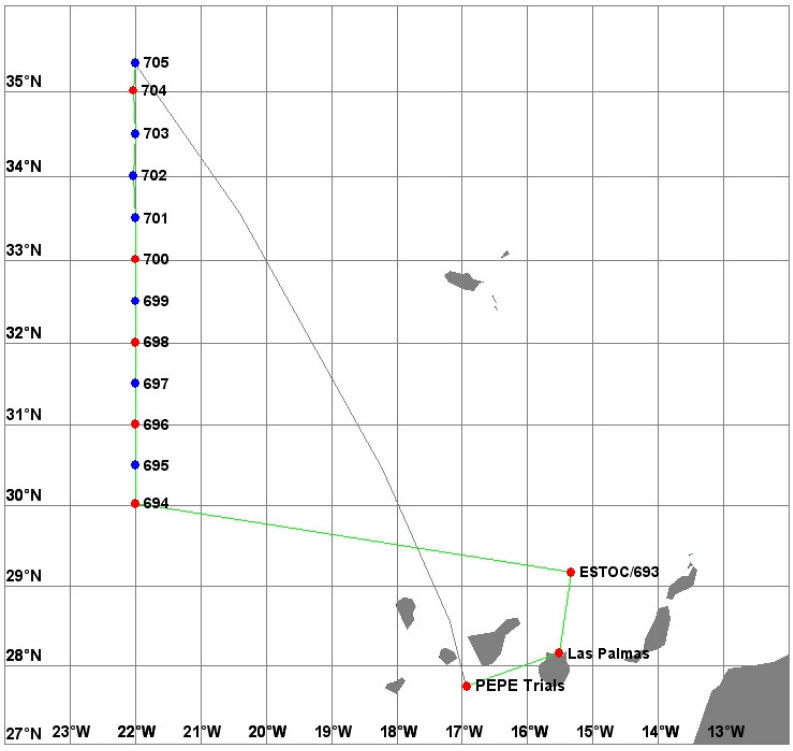


Fig.1 Cruise track of P377 with position of the combined CTD/MCN stations (red dots), XBT stations (blue dots) and the PEPE testing area south of Tenerife. The grey line indicate the transit from the meridional transect to the second working area.

Over the duration of the cruise due to continuously bad weather conditions only small number of combined CTD /MCN (multi-closing net) stations was occupied (see Appendix A1 & B) and on 6 positions XBT's (Expandable bathythermographs) were deployed (Fig.1).

All the CTD profiles were carried out down to 2000m depths. From the CTD bottles samples for nutrient analysis, suspended particulate matter and chlorophyll a analysis were taken at selected depth. The water samples for chlorophyll a and suspended particulate matter were filtered on board and stored frozen for the analysis in the home laboratory. Water samples for the estimation of the nutrient concentration were filtrated to eliminate biological activity and stored frozen (-40C) until analysis at IOW in January 2009 by B. Sadkowiak (Dep. Marine Chemistry). The samples for chlorophyll a are being processed right know. At the central station (33N, 22W) for the projects behind the cruise also samples for the SEM analysis have been collected from selected depth.

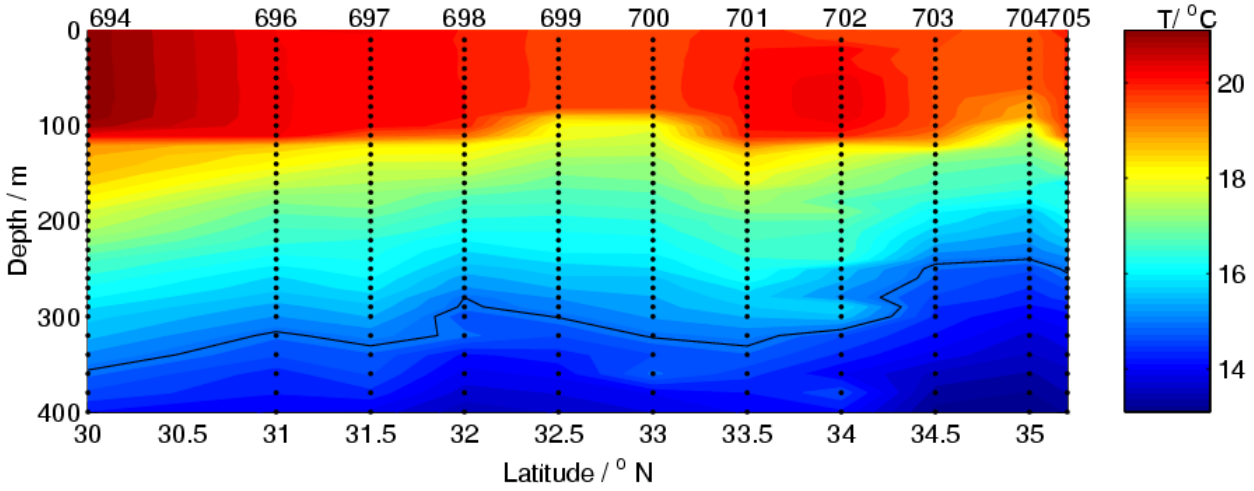


Fig.2. Vertical temperature distribution (surface to 400m depth) based on CTD and XBT temperature measurements. On top is the station number indicated, the black dots indicate the measurements (10 m resolution is shown for graphical reasons only). Data from station 695 were not used as the XBT malfunctioned, and the values at station 702 in the depth interval 240 to 300m and 340 to 380m were interpolated using data from station 701 and 703 because the XBT showed spikes.

Figure 2 shows the vertical temperature distribution in the upper 400m depths along the 22W between 33N and 35.2N. The first 100m is occupied by warm water body with temperatures ranging between 21.2C at 30N and 19.6C at 35.2N with sharp gradient below and decreasing temperatures. The black line in figure 2 indicates the position of the 15-degree isotherm, which is often used to detect the Azores Front. In December 2008 the isotherm was found deeper than 300m between 30N and 34N. From 34N towards North an uplifting of the isotherm was seen, however the isotherm did not reach 200m depths. This means that we did not hit the centre of the front. Due to bad weather conditions found at 35.2N further sampling was not possible.

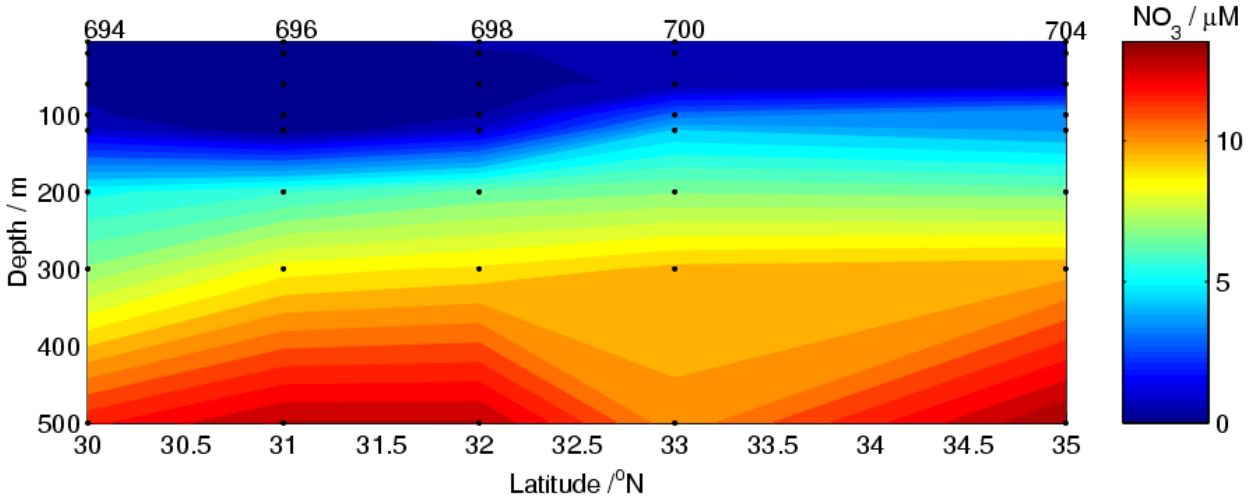


Fig.3. Vertical nitrate distribution (surface to 500m depth) based on samples taken from the CTD. On top is the station number indicated, the black dots indicate the sample depth. At stations 695, 697, 699, 701-703 and 705 only XBT's were deployed and therefore no water samples have been obtained.

The nitrate concentrations measured in the region in December 2008 show everywhere at surface values below 0.5 µM, apart from station 698 and 700 (0.6-0.7 µM). Below, the upper 100 to 200 m were dominated by concentrations <1 µM n the southern part of the transect (stations 694-698), whereas slightly higher concentrations were found at stations 700 and 704. At all stations however a steep gradient below 200m and 120m depths respectively was observed (Fig.3).

The question to what extend the available nutrients have been already utilised by phytoplankton will be answered as soon as the chlorophyll a measurements are available and are analysed. The work on the data obtained during the POS377 is ongoing.

4.2. Planktic foraminifera (H. Howa (BIAF), A. Rebotim (LNEG), R. Schiebel (BIAF))

Living planktic foraminifers were collected with the multiple closing net for investigations of their vertical distribution and ecology in the winter period. Planktic foraminifers have been sampled with a multiple closing net with 100 µm mesh size. Samples were collected from different water depth intervals, 0-100 m at 20-m intervals, 100-700 at 100 m and 200 m intervals, and 700-2000 m at 300 m and 500 m intervals (Table 1). Foraminiferal tests have been picked and processed for analysis of (a) molecular genetics (BIAF). Rest of the bulk MCN samples have been fixed in formaldehyde for analyses in the laboratory in France and some stable isotope analysis (INETI, Lisbon).

The planktic foraminiferal fauna has been significantly depleted in terms of specimens and species compared to the spring period previously investigated (Cruise P349 – April 2007). Along

the 22ºW transect, from the south (30°N) to the north (35°N), the size of almost all living individuals remains relatively small (~200 µm). The planktic foraminiferal live assemblage was dominated by *Globigerinella siphonifera* and *Globigerinoides ruber*. *Orbulina universa* and *Globorotalia truncatulinoides* were frequent. Occasionally, *Globigerinita glutinata, Globigerina falconensis, Globoturborotalia tenella* and *Globorotalia hirsuta* were present. The assemblage of empty shells was similar to the live assemblage. *Globorotalia scitula* and *Hastigerina pelagica,* the dominant species at subsurface waters in April 2007, were not found in December 2008.

Table 1. Planktic foraminiferal samples collected on Poseidon cruise 377

Site	Latitude (˚)	Longitude (˚)	Water Depth Interval (m)
693	29 10.3742N	21 19.4802W	100
694	29 59.9892N	22 0.0000W	100, 700, 2000
696	30 59.8860N	21 59.7930W	100, 700, 700
698	32 0.0090N	22 0.0270W	100, 700
704	35 0.5040N	21 59.6532W	100, 700, 700, 2000

Cytoplasm bearing specimens were selected within these samples for biogeochemical analyses. Individual specimens were picked from the bulk sample, cleaned with a brush within a drop of deionised water for 5 seconds, and frozen at -40˚C. Analyses of the soft tissue and shell composition will be carried out at BIAF, Angers University.

4.3. Pre-investigations for a deep-sea pressure tolerant systems development project

The aim of the project is the development and introduction of high pressure resistant mechanical and highly integrated electronic components as well as battery systems without pressure vessels for oceanographic and maritime research. Traditionally used pressure tubes or spheres for maritime equipment require expensive body and sealing materials as well as highly precise production technology. They lead to hefty and heavyweight system parts and more often produce failures by aging and corrosion of materials and sealing's. By the enormous development of monolithic electronic components and high tech moulding materials in the last two decades new possibilities emerged for the design system components without. Thereby complex electronic and micro-mechanic systems can be designed and embedded completely pressure tolerant up to overpressures of more than 1000 bars. As an example for the introduction of the pressure tolerant technology in maritime systems in a running project a complex Autonomous Unmanned Vehicle has been developed and successfully tested in the Baltic Sea including all components from energy supply over the necessary control systems up to the drives, communication and data transmission systems. All basic pressure tolerant components have been pre-qualified with lab testing facilities for more than 600 bars so that a deep-sea project can be initiated. At the same time close contacts to state of the art under water acoustic communication partners have been

developed, because reliable long distance under water communication is absolutely essential for a deep sea development project.

Therefore in December 2008 on RV POSEIDON cruise 377 scientific investigations according the Azores front in the Madeira basin were combined with a pre-qualification of a combined test system down to 5000m. A combination of new USBL acoustic modems in traditional pressure vessel technology with a pressure tolerant robot head was operated as a partly pressure tolerant subsystem. The new S2C acoustic modem with USBL module provides reliable long acoustic communication with positioning. The robot head was attached to the 5000m coaxial CTD cable of the vessel. It includes pressure tolerant thrusters, batteries and control units and an acoustic modem. It can be recharged and controlled via the coaxial cable. Detection and control are even possible via the acoustic USBL modem system. The function of all pressure tolerant components and the acoustic guidance and communication were properly qualified down to 3000 m for more than several hours.

Pressure Tolerant Systems (C. Thiede & S. Krüger & H. Huth)

A robot head was used for testing pressure tolerant systems in deep water (Fig.4). The robot head was attached to a 5000m coaxial CTD cable for energy supply and communication. It is equipped with two horizontally acting thrusters and one vertical thruster. The communication between the robot head and topside control was realized by a three-channel frequency modulated unidirectional connection via the coaxial CTD cable. The operators topside unit has an adjustable modulator to set the proper amplification for the binary coded thruster commands. Best channel separation was performed at 90% amplification level. It was possible to get control of all the thrusters via the 5100 m coaxial cable.

The robot was to light weight to produce enough tension for proper winch operation. To avoid problems with the winch two extra weights were attached to the robot to get a useable drag on to the winch. A third additional weight was mounted on the joint between the coaxial cable and the robot head. As expected a tilt with thrusters and the additional weights was not possible. A buffered rechargeable battery produced the energy for the thrusters and the acoustic modem. The main power comes from the topside power unit. It can produce about 370 V up to 2 Amp. A pressure tolerant DC converter buffers the rechargeable battery due working thrusters. Further parallel charging was also possible. The battery works well also under high pressure and temperatures down to 2.5°C. Some noise problems from DC converters were detected because they work in the same ultrasonic frequency range like the acoustic modems. After more than 6 hours of using the robot head in depth up to 3000 m no problems with pressure tolerant systems were observed.

On the second dive to 3000 m abnormal performing of the topside unit was registered. Several times the connection to the robot head seems to be lost. A power loose of the acoustic modem required a shut down of the topside power supply to prevent any damage. The robot was lifted on deck. After some test we decided, that the acoustic modem has power but the main power switch did not work properly. To find the cause of malfunction we disassembled the robot head and found some water in the battery management system. By opening the silicon coating and disconnecting the battery from further damage to the system have been prevented. However, the source of the incoming water problem is still unknown. To continuo the tests, we extracted the battery from the robot system and build a stand-alone power supply for the acoustic modem (Fig.5). This system was mounted on the CTD. Even in this configuration the pressure tolerant rechargeable battery works very well.

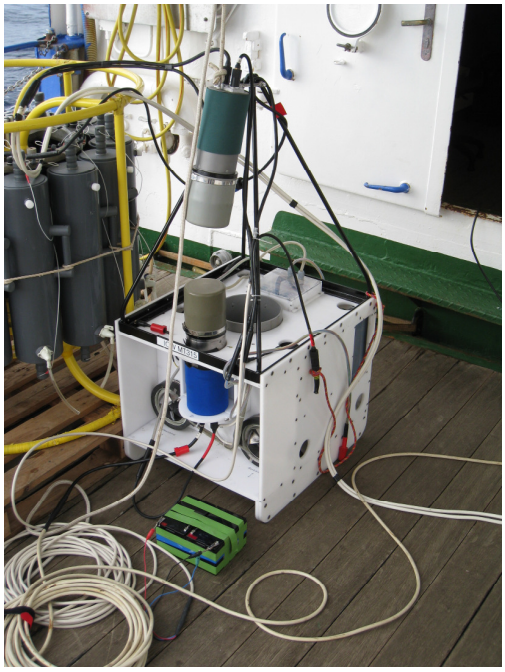


Fig. 4. Dry run of acoustic modems.

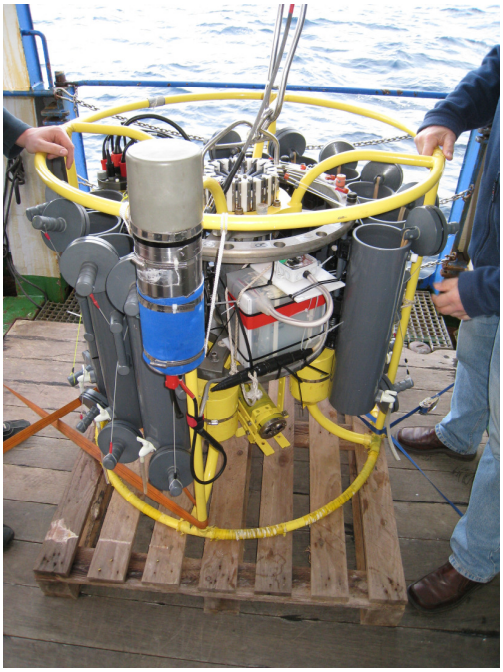


Fig. 5. Test of the pressure tolerant power supply for the acoustic modem on a CTD.

Acoustic modems (O. Kebkal & G. Pleskach)

During the P377 trial phase, S2C modems have shown good performance with low energy requirements, for data delivery. Mean nominal bit rate achieved during trials at 3000 meters was 8500 bps, with a maximum mean nominal bit rate of 9200 bps. No errors were detected in received data files in all test cases. The modems required about 3W in transmit mode to communicate across distances up to 2500 m and about 5W in transmit mode to communicate across distances up to 3300 m.

The S2C modems showed stable acoustic connection during the ship manoeuvres and during the heaving up and down of the robot head. So, additionally, during the data delivery, S2C modems also provided a possibility to measure relative distance and relative velocity of modems with a high degree of accuracy (within an accuracy of a few centimetres for distance measurement and less than 0.1 m/s for velocity measurement). Figure 6 shows the result of the relative distance measurement of the ship and a robot head placed on the depth of about 1000 meters, during a 180-degree turn of the ship. Figure 7 shows the relative distance measurement results during stepwise heaving up and down of the robot head, made during the tests for extensive USBL antenna measurement investigation. Figure 8 shows an enlarged section of the previous plot from which it is possible to clearly see the rolling of the ship as a function of relative distances between communicating modems.

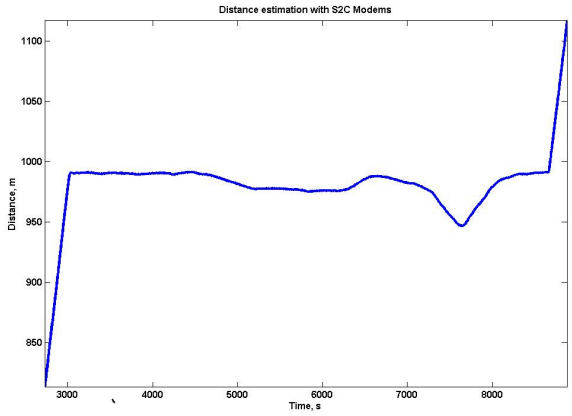


Fig. 6. Ship manoeuvre

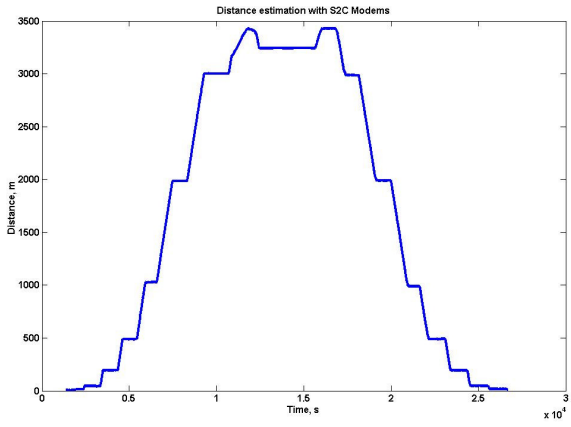


Fig. 7. Test on different depths

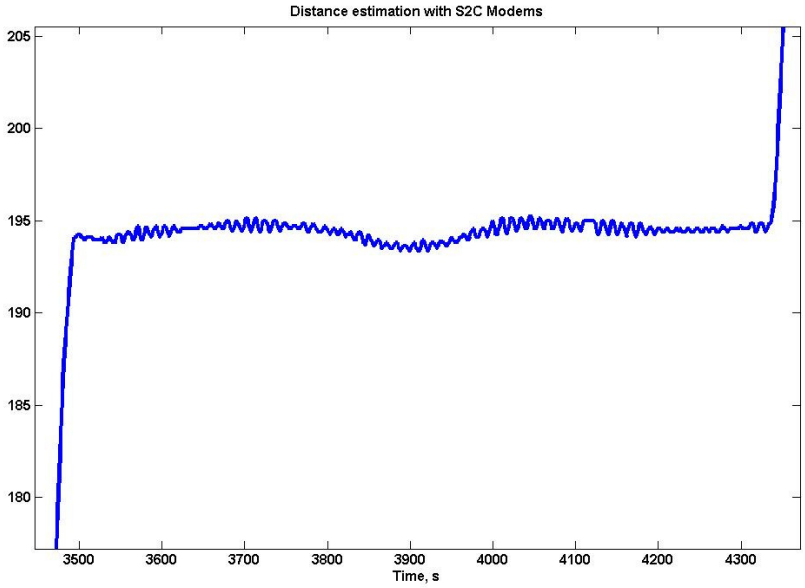


Fig. 8. Ship rolling recovered as a function of relative distances between communicating modems.

Analysis of the results of the received signal processing from the newly designed S2C USBL antenna in different geometries showed some failure of one of the receiving channels, which is being investigated. The antenna needs to be tested again.

5. Scientific equipment, moorings and instruments

5.1. CTD/ Water Sampling

CTD measurements were performed with IOW-CTD-system SBE911+, SN -721 down to 3600 m, but mostly down to 2000m depths. The system included the following sensors: Temperature SN: 4525, Conductivity SN: 3246, Pressure SN: 90550, Oxygen SBE 43 SN: 0521, Altimeter SN: 1018, Fluorometer: Dr. Haardt Phycoerythrin, Chlorophyll a, Turbidity SN: 12100. Parallel water sampling was done with the integrated SBE32 rosette sampler equipped with a total of 13 Bottles with 5 l volume HYDROBIOS FreeFlow® - Bottles from variable depths.

5.2. XBT

The expandable bathythermograph probe T5 (Lockheed Martin Sippican Inc.) was used during this cruise to measure temperature versus depth. Temperature profiles were obtained every 30nm (see Appendix B) down to 1830 m, while the ship was sailing at 6 knots.

5.3. Multinet Sampling

A Hydrobios multiple opening closing net was used to collect samples of planktic organisms by vertical hauls (100-µm mesh size, 50x50 cm2 opening).

5.4. PC-Log

A PC-Based programme package consecutively logged the data streams from the ship's navigational units, as well as from the thermosalinograph and from the DWD (Deutscher Wetterdienst) sensors. In parallel the IOW CruiseAssistant system logged the corresponding data streams and provided cruise planning and CTD control with integrated ships data.

5.5. IOW Instrument development program – pre-investigations for a new DRUSYS Deep See project

5.5.1 Pressure tolerant marine technologies and robots

A newly developed pressure tolerant ROV like robot head equipped with two electrical horizontal thrusters and one vertical thruster was tested and deployed. The power comes from a 16 Ah rechargeable battery. The battery is buffered over the coaxial cable from a topside unit. The unit produce up to 360 V on 2 A electrical power. As communication a unidirectional frequency modulated signal in three channels via the coaxial was used. The control unit give the possibility to control the robot to forward, backward rotate, up and down. The topside power unit provide battery charging also at high depth via the coaxial. The robot frame is made from plastic. The main material for the pressure tolerant coatings is silicon gel.

5.5.2. S2C acoustic modem technology

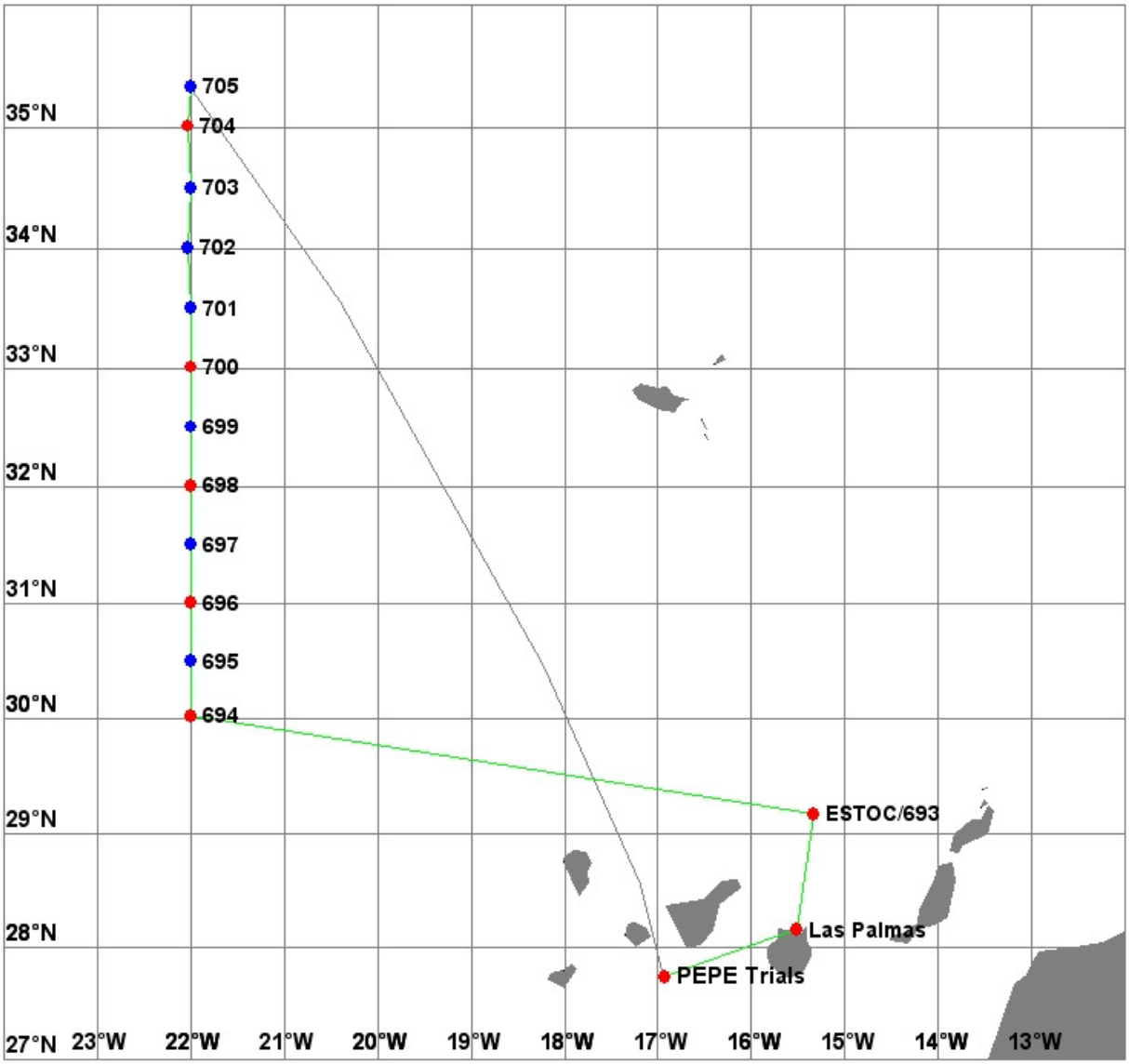
A standard EVOLOGICS S2C acoustic modem and a newly developed USBL omni directional acoustic receiver were installed into the ships moon pool. Between the CTD-Stations and during a separate cruise program a robot head from ENITECH with pressure tolerant rechargeable batteries, electronic control units and thrusters carrying a similar S2C deep sea modem was deployed via the (CTD-) coaxial cable at several depth levels or was towed in different levels behind the ship.

6. Acknowledgements

We would like to thank Captain Michael Schneider and his crew for their cooperation and help during this cruise. We also would like to thank Birgit Sadkowiak for measuring the nutrient data.

7. Appendices

A. Map



A1) Cruise track of P377 with position of the combined CTD/MCN stations (red dots), XBT stations (blue dots) and the PEPE testing area south of Tenerife. The grey line indicate the transit from the meridional transect to the second working area.

B. Station list

Station No.	Date	Time UTC	Action	Latitude			Longitude			T °C Air	T °C Water
693	08.12.	18:10	Ship on station	29°	10,06'	N	015°	19,98'	W	16,9	20,1
		18:11	CTD/Ro t/water	29°	10,06'	N	015°	19,98'	W	16,9	20,1
		19:19	Heave CTD/Ro	29°	10,24'	N	015°	19,71'	W	18,2	20,0
		20:45	CTD/Ro @ deck	29°	10,38'	N	015°	19,42'	W	18,7	20,0
		20:45	Station completed	29°	10,38'	N	015°	19,42'	W	18,7	20,0
693-2	08.12.	21:06	Ship on station	29°	10,37'	N	015°	19,48'	W	18,7	20,0
		21:07	MSN t/water	29°	10,37'	N	015°	19,48'	W	18,7	20,0
		21:13	Heave MSN	29°	10,36'	N	015°	19,47'	W	18,7	20,0
		21:20	MSN @ deck	29°	10,37'	N	015°	19,45'	W	18,7	20,0
		21:28	Station completed	29°	10,35'	N	015°	19,43'	W	18,7	20,0
694	10.12.	15:09	Ship on station	29°	59,96'	N	022°	00,01'	W	18,4	21,1
		15:17	ADCP @ deck	29°	59,96'	N	021°	59,97'	W	18,4	21,1
		15:54	ADCP t/water	29°	59,96'	N	021°	59,96'	W	18,2	21,1
		16:00	Modem t/water	29°	59,97'	N	021°	59,98'	W	18,2	21,1
		16:03	Roboter Pepe t/water	29°	59,97'	N	021°	59,98'	W	18,4	21,1
		16:05	Heave	29°	59,97'	N	022°	00,02'	W	18,4	21,1
		16:07	Roboter Pepe @ deck	29°	59,97'	N	022°	00,01'	W	18,5	21,1
		16:07	Station completed	29°	59,97'	N	022°	00,01'	W	18,5	21,1
694-2	10.12.	16:30	Ship on station	29°	59,95'	N	022°	00,01'	W	18,5	21,1
		16:30	Hydrophone t/water	29°	59,95'	N	022°	00,01'	W	18,5	21,1
		16:32	Roboter Pepe t/water	29°	59,95'	N	022°	00,03'	W	18,0	21,1
		17:20	Heave	29°	59,97'	N	022°	00,06'	W	18,0	21,1
		17:23	Robot./ Hydroph. @ deck	29°	59,95'	N	022°	00,06'	W	18,0	21,1
		17:23	Station completed	29°	59,95'	N	022°	00,06'	W	18,0	21,1
694-3	10.12.	17:40	Ship on station	29°	59,99'	N	022°	00,01'	W	18,3	21,1
		17:44	CTD/Ro t/water	29°	59,99'	N	022°	00,01'	W	18,3	21,1
		18:26	Heave CTD/Ro	29°	59,93'	N	022°	00,01'	W	18,5	21,1
		19:09	CTD/Ro @ deck	29°	59,99'	N	022°	00,01'	W	18,5	21,1
		19:09	Station completed	29°	59,99'	N	021°	59,99'	W	18,5	21,1

Station No.	Date	Time UTC	Action	Latitude			Longitude			T °C Air	T °C Water
694-4	10.12.	19:20	Ship on station	29°	59,98'	N	021°	59,99'	W	18,5	21,1
		19:20	MSN t/water	29°	59,98'	N	021°	59,98'	W	18,5	21,1
		19:25	Heave MSN	29°	59,97'	N	021°	59,98'	W	18,3	21,1
		19:32	MSN @ deck	29°	59,99'	N	021°	59,97'	W	18,3	21,1
		19:32	Station completed	29°	59,99'	N	021°	59,98'	W	18,2	21,1
694-5	10.12.	19:43	Ship on station	29°	59,97'	N	022°	00,04'	W	18,2	21,1
		19:43	MSN t/water	29°	59,97'	N	022°	00,04'	W	18,2	21,1
		20:03	Heave MSN	29°	59,93'	N	022°	00,00'	W	18,3	21,1
		20:26	MSN @ deck	29°	59,94'	N	022°	00,00'	W	18,1	21,1
		20:31	Station completed	29°	59,97'	N	022°	00,00'	W	18,1	21,1
694-6	10.12.	20:38	Ship on station	29°	59,98'	N	022°	00,00'	W	18,2	21,1
		20:38	MSN t/water	29°	59,98'	N	022°	00,00'	W	18,4	21,1
		21:36	Heave MSN	30°	00,00'	N	022°	00,00'	W	18,3	21,0
		22:37	MSN @ deck	30°	00,00'	N	021°	59,98'	W	18,0	21,0
		22:43	Station completed	30°	00,00'	N	022°	00,00'	W	18,2	21,0
695	11.12.	03:17	Ship on station	30°	30,06'	N	022°	00,00'	W	16,6	20,6
		03:18	XBT t/water 1. Versuch	30°	30,09'	N	022°	00,00'	W	16,6	20,6
		03:22	XBT t/water 2. Versuch	30°	30,59'	N	022°	00,00'	W	16,6	20,6
		03:24	XBT t/water 3. Versuch	30°	30,87'	N	022°	00,00'	W	16,6	20,6
		03:27	Station completed	30°	31,06'	N	022°	00,00'	W	16,6	20,6
696	11.12.	08:00	Ship on station	31°	00,00'	N	022°	00,00'	W	18,1	20,2
		08:03	CTD/Ro t/water	31°	00,00'	N	022°	00,00'	W	18,2	20,2
		08:48	Heave CTD/Ro	30°	59,93'	N	021°	59,94'	W	17,2	20,2
		09:32	CTD/Ro @ deck	30°	59,81'	N	021°	59,84'	W	16,2	20,2
		09:32	Station completed	30°	59,81'	N	021°	59,84'	W	16,2	20,2
696-2	11.12.	09:46	Ship on station	30°	59,90'	N	021°	59,81'	W	17,2	20,1
		09:46	MSN t/water	30°	59,90'	N	021°	59,81'	W	17,3	20,2
		09:51	Heave MSN	30°	59,88'	N	021°	59,79'	W	17,5	20,2
		09:57	MSN @ deck	30°	59,85'	N	021°	59,76'	W	17,5	20,2
		09:57	Station completed	30°	59,85'	N	021°	59,76'	W	17,6	20,2

Station No.	Date	Time UTC	Action	Latitude			Longitude			T °C Air	T °C Water
696-3	11.12.	10:10	Ship on station	30°	59,91'	N	021°	59,79'	W	17,7	20,1
		10:10	MSN t/water	30°	59,91'	N	021°	59,79'	W	17,7	20,1
		10:32	Heave MSN	30°	59,89'	N	021°	59,75'	W	17,9	20,1
		10:57	MSN @ deck	30°	59,91'	N	021°	59,75'	W	18,1	20,1
		10:58	Station completed	30°	59,91'	N	021°	59,75'	W	18,1	20,1
696-4	11.12.	11:04	Ship on station	30°	59,90'	N	021°	59,73'	W	17,5	20,1
		11:04	MSN t/water	30°	59,90'	N	021°	59,73'	W	17,5	20,1
		11:27	Heave MSN	30°	59,91'	N	021°	59,66'	W	17,8	20,1
		11:50	MSN @ deck	30°	59,92'	N	021°	59,64'	W	18,5	20,1
		11:51	Station completed	30°	59,92'	N	021°	59,61'	W	18,6	20,1
697	11.12.	16:07	Ship on station	31°	30,04'	N	022°	00,01'	W	16,9	20,0
		16:08	XBT t/water 1. Versuch	31°	30,04'	N	022°	00,01'	W	16,9	20,0
		16:14	Station completed	31°	30,63'	N	022°	00,01'	W	16,9	20,0
698	11.12.	20:21	Ship on station	31°	59,99'	N	022°	00,03'	W	17,8	19,9
		20:23	CTD/Ro t/water	31°	59,98'	N	022°	00,03'	W	17,8	19,9
		21:06	Heave CTD/Ro	31°	59,98'	N	022°	00,00'	W	18,3	19,9
		21:51	CTD/Ro @ deck	31°	59,98'	N	022°	00,01'	W	18,0	19,9
		21:51	Station completed	31°	59,99'	N	022°	00,01'	W	18,0	19,9
698-2	11.12.	21:58	Ship on station	32°	00,00'	N	022°	00,01'	W	17,9	19,9
		21:58	MSN t/water	32°	00,00'	N	022°	00,02'	W	17,9	19,9
		22:03	Heave MSN	32°	00,00'	N	022°	00,01'	W	17,9	19,9
		22:08	MSN @ deck	32°	00,00'	N	022°	00,01'	W	17,9	19,9
		22:09	Station completed	32°	00,00'	N	021°	59,99'	W	18,1	19,9
698-3	11.12.	22:17	Ship on station	32°	32,01'	N	021°	59,99'	W	18,1	19,9
		22:17	MSN t/water	32°	32,01'	N	021°	59,98'	W	18,0	19,9
		22:39	Heave MSN	32°	32,01'	N	021°	59,91'	W	18,0	19,9
		23:00	MSN @ deck	32°	32,05'	N	021°	59,93'	W	17,8	19,9
		23:03	Station completed	32°	32,03'	N	021°	59,93'	W	18,0	19,9
699	12.12.	03:33	Ship on station	32°	30,00'	N	022°	00,01'	W	17,3	19,6
		03:34	XBT t/water 1. Versuch	32°	30,06'	N	022°	00,01'	W	17,3	19,6

Station No.	Date	Time UTC	Action	Latitude			Longitude			T °C Air	T °C Water
		03:36	Station completed	32°	30,34'	N	022°	00,01'	W	17,3	19,6
700	12.12.	10:00	Ship on station	33°	00,03'	N	021°	48,31'	W	17,3	19,6
		10:06	CTD/Ro t/water	33°	00,03'	N	021°	48,34'	W	17,3	19,6
		10:48	Heave CTD/Ro	32°	59,99'	N	021°	48,24'	W	17,4	19,5
		11:35	CTD/Ro @ deck	33°	00,00'	N	021°	48,14'	W	17,2	19,7
		11:35	Station completed	33°	00,00'	N	021°	48,14'	W	17,2	19,7
701	12.12.	16:48	Ship on station	33°	30,03'	N	022°	00,01'	W	17,6	19,9
		16:49	XBT t/water	33°	30,06'	N	022°	00,01'	W	17,6	19,9
		16:54	Station completed	33°	30,63'	N	022°	00,01'	W	17,6	19,9
702	12.12.	21:39	Ship on station	34°	00,00'	N	022°	00,00'	W	16,9	19,8
		21:39	XBT t/water	34°	00,00'	N	022°	00,00'	W	16,9	19,8
		21:45	Station completed	34°	00,44'	N	022°	00,00'	W	16,8	19,7
703	13.12.	01:57	Ship on station	34°	30,00'	N	022°	00,00'	W	16,8	19,5
		01:58	XBT t/water	34°	30,05'	N	022°	00,00'	W	16,8	19,5
		02:02	Station completed	34°	30,66'	N	022°	00,00'	W	16,8	19,5
704	13.12.	06:17	Ship on station	35°	00,01'	N	022°	00,00'	W	17,3	19,4
		06:19	CTD/Ro t/water	35°	00,01'	N	022°	00,00'	W	17,3	19,4
		06:59	Heave CTD/Ro	35°	00,09'	N	022°	00,00'	W	17,6	19,4
		07:38	CTD/Ro @ deck	35°	00,23'	N	021°	59,98'	W	17,7	19,4
		07:38	Station completed	35°	00,23'	N	021°	59,98'	W	17,7	19,4
704-2	13.12.	08:05	Ship on station	34°	59,93'	N	021°	59,94'	W	17,6	19,4
		08:14	MSN t/water	34°	59,99'	N	022°	00,00'	W	17,4	19,4
		09:16	Heave MSN	35°	00,05'	N	021°	59,64'	W	17,9	19,4
		10:22	MSN @ deck	35°	01,04'	N	021°	59,17'	W	18,1	19,3
		10:23	Station completed	35°	01,04'	N	021°	59,17'	W	18,1	19,3
704-3	13.12.	10:52	Ship on station	34°	59,41'	N	022°	00,53'	W	18,6	19,4
		10:52	MSN t/water	34°	59,41'	N	022°	00,53'	W	18,6	19,4
		11:17	Heave MSN	35°	59,67'	N	022°	00,27'	W	18,5	19,4
		11:42	MSN @ deck	35°	00,00'	N	022°	00,03'	W	18,4	19,3
		11:43	Station completed	35°	00,00'	N	022°	00,03'	W	18,4	19,3

Station No.	Date	Time UTC	Action	Latitude			Longitude			T °C Air	T °C Water
704-4	13.12.	12:00	Ship on station	35°	00,27'	N	021°	59,90'	W	18,4	19,4
		12:02	MSN t/water	35°	00,27'	N	021°	59,88'	W	18,4	19,4
		12:06	Heave MSN	35°	00,35'	N	021°	59,83'	W	18,4	19,4
		12:12	MSN @ deck	35°	00,40'	N	021°	59,85'	W	18,4	19,4
		12:12	Station completed	35°	00,40'	N	021°	59,85'	W	18,4	19,4
704-5	13.12.	12:48	Ship on station	34°	59,27'	N	022°	00,62'	W	18,4	19,4
		12:49	MSN t/water	34°	59,27'	N	022°	00,62'	W	18,4	19,4
		13:06	Heave MSN	34°	59,46'	N	022°	00,49'	W	18,4	19,4
		13:30	MSN @ deck	34°	59,70'	N	022°	00,24'	W	18,4	19,4
		13:30	Station completed	34°	59,70'	N	022°	00,24'	W	18,4	19,4
704-6	13.12.	13:51	Loteinsatz t/water	35°	00,03'	N	022°	00,20'	W	18,4	19,4
		13:56	Modem Fra,me "Pepe" t/water	35°	00,10'	N	022°	00,16'	W	18,4	19,4
		15:55	Loteinsatz @ Deck	35°	01,07'	N	021°	59,95'	W	18,4	19,4
		15:58	Heave Roboterkopf	35°	01,09'	N	021°	59,96'	W	18,4	19,4
		16:31	"Pepe" @ Deck	35°	01,26'	N	021°	59,76'	W	18,4	19,4
		16:31	Station completed	35°	01,26'	N	021°	59,76'	W	18,4	19,4
705	13.12.	21:25	Ship on station	35°	19,58'	N	021°	59,35'	W	19,1	19,8
		21:25	XBT t/water	35°	19,58'	N	021°	59,35'	W	19,1	19,8
		21:32	XBT t/water	35°	18,93'	N	021°	59,35'	W	19,1	19,7
		21:37	Station completed	35°	18,38'	N	021°	59,35'	W	19,1	19,7
706	17.12.	08:00	Ship on station	27°	44,04'	N	016°	56,06'	W	17,8	19,6
		08:04	CTD/Ro t/water	27°	44,04'	N	016°	56,06'	W	17,8	19,6
		09:06	Heave CTD/Ro	27°	44,00'	N	016°	56,02'	W	17,9	19,6
		11:30	CTD/Ro @ deck	27°	44,08'	N	016°	56,00'	W	18,2	19,6
		11:30	Station completed	27°	44,08'	N	016°	56,00'	W	18,2	19,6
706-2	17.12.	11:30	Ship on station	27°	44,08'	N	016°	56,00'	W	18,2	19,6
		12:15	Modem t/water	27°	43,97'	N	016°	56,01'	W	18,0	19,6
		12:30	"Pepe" t/water	27°	43,97'	N	016°	56,01'	W	18,0	19,6
		15:13	Heave up "Pepe"	27°	44,01'	N	016°	56,02'	W	18,1	19,7
		16:12	"Pepe" @ Deck	27°	43,92'	N	016°	56,08'	W	18,0	19,7

Station No.	Date	Time UTC	Action	Latitude			Longitude			T °C Air	T °C Water
		16:13	Station completed	27°	43,92'	N	016°	56,08'	W	18,0	19,7
707	18.12.	08:05	Ship on station	27°	44,01'	N	016°	56,00'	W	18,0	19,6
		08:20	Modem u. "Pepe" t/water	27°	43,99'	N	016°	56,00'	W	17,9	19,6
		12:24	Heave up "Pepe"	27°	44,02'	N	016°	55,92'	W	17,6	19,6
		13:15	"Pepe" @ Deck	27°	43,99'	N	016°	56,04'	W	17,6	19,6
		14:00	Modem @ Deck	27°	44,00'	N	016°	56,03'	W	17,9	19,6
		14:00	Station completed	27°	44,00'	N	016°	56,03'	W	17,9	19,6
707-2	18.12.	15:15	Ship on station	27°	43,99'	N	016°	56,01'	W	18,0	19,7
		15:15	CTD t/water	27°	43,99'	N	016°	56,01'	W	18,0	19,7
		15:40	Heave CTD	27°	43,95'	N	016°	56,06'	W	18,1	19,7
		16:00	CTD @ deck	27°	43,94'	N	016°	56,08'	W	18,3	19,7
		16:00	Station completed	27°	43,94'	N	016°	56,08'	W	18,3	19,7
708	19.12.	08:00	Ship on station	27°	44,00'	N	016°	56,00'	W	17,6	19,5
		08:34	CTD+Pepe-parts t/water	27°	44,02'	N	016°	56,00'	W	17,9	19,5
		11:32	Heave CTD+Pepe-parts	27°	44,00'	N	016°	56,01'	W	17,2	19,5
		12:19	Modem @ Deck	27°	43,97'	N	016°	56,03'	W	17,4	19,5
		12:30	Modem t/water	27°	43,98'	N	016°	56,01'	W	17,4	19,5
		15:59	CTD @ deck	27°	43,99'	N	016°	56,04'	W	16,1	19,5
		16:11	Modem @ Deck	27°	43,98'	N	016°	55,90'	W	15,9	19,5
		16:11	Station completed	27°	43,99'	N	016°	55,90'	W	15,9	19,5
709	20.12.	07:36	Ship on station	27°	44,00'	N	016°	56,00'	W	18,5	19,5
		08:28	CTD t/water	27°	44,00'	N	016°	56,00'	W	18,7	19,5
		09:40	Heave CTD	27°	44,01'	N	016°	56,00'	W	18,8	19,5
		09:49	CTD @ deck	27°	44,01'	N	016°	56,00'	W	19,2	19,5
		09:49	Station completed	27°	44,01'	N	016°	56,00'	W	19,2	19,5
709-2	20.12.	10:03	Ship on station	27°	44,00'	N	016°	56,00'	W	19,1	19,5
		10:03	CTD t/water	27°	44,00'	N	016°	56,00'	W	19,1	19,5
		11:26	Heave CTD	27°	44,00'	N	016°	56,00'	W	18,9	19,5
		13:31	CTD @ deck	27°	44,00'	N	016°	56,02'	W	18,7	19,5
		13:32	Station completed	27°	44,00'	N	016°	56,00'	W	18,7	19,5